WO 00/67202
PCT/IB00/00606

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(PCT Rule 47.1(c), first sentence)

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| **Date of mailing** (day/month/year)<br>09 November 2000 (09.11.00) | |
| **Applicant's or agent's file reference**<br>14XZ00074 | **IMPORTANT NOTICE** |

| **International application No.** | **International filing date** (day/month/year) | **Priority date** (day/month/year) |
|---|---|---|
| PCT/IB00/00606 | 28 April 2000 (28.04.00) | 29 April 1999 (29.04.99) |

**Applicant**
GE MEDICAL SYSTEMS SA et al

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   US

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
G06T 5/50

A1

(11) International Publication Number: WO 00/67202

(43) International Publication Date: 9 November 2000 (09.11.00)

(21) International Application Number: PCT/IB00/00606

(22) International Filing Date: 28 April 2000 (28.04.00)

(30) Priority Data:
99/05438 29 April 1999 (29.04.99) FR

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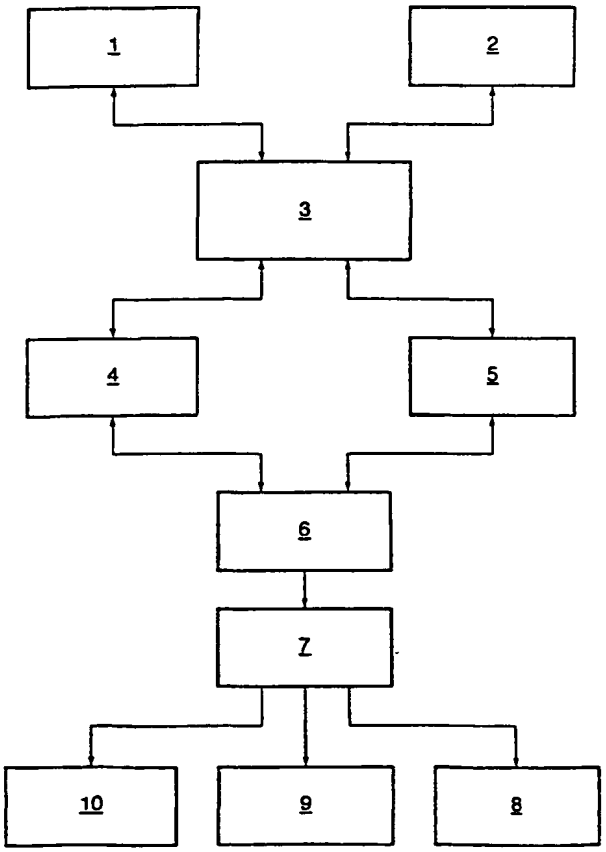
(81) Designated States: IL, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

**Published**
*With international search report.*
*Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.*

(54) Title: CT/MR FUSED IMAGE PRESENTATION ALGORITHM

(57) Abstract

Method of fusion of a first digital radiographic image obtained as a result of scanning with a second digital radiographic image obtained by magnetic resonance imaging (MRI). A CT interval of gray levels is selected first in the scanner image. Each pixel of the scanner image having a gray level lying within the CT interval is then replaced by a pixel obtained by digital processing of the pixel of the same coordinates as the MRI image. Then, the final image corresponds to the scanner image in which the pixels of gray levels lying within the CT interval have undergone said digital processing.



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# CT/MR FUSED IMAGE PRESENTATION ALGORITHM

## BACKGROUND OF THE INVENTION

The invention concerns the fusion of two digital images of an object, the first image of which favors a particular constituent of the object, while the second image favors another.

It has a particularly important application in the medical field, in which a first image of a body organ obtained by scanning is fused with a second image of the same organ obtained by magnetic resonance imaging (MRI).

In fact, an image obtained by means of a scanner particularly reveals the bony part. In such an image, the bony part is white and all the other parts, especially, the soft tissues, are of a homogeneous gray without contrast. On the other hand, an image obtained by means of MRI reveals the soft tissues in different shades of gray levels and the other parts like the bony parts and empty space are black.

In general, in the medical field a scanner image is fused with an MRI image by integrating the pixels of the bony parts of the scanner image in the MRI image.

The scanner images possess an absolute scale of gray levels, that is, all the scanner images are compatible with one another, in the sense that a given gray level always represents a particular organ. This absolute scale is the Hounsfield scale, composed of positive and negative numbers, in which the 0 level is the gray level of water.

An MRI image does not possess an absolute scale. The gray levels depend on the patient and on the image acquisition conditions. Therefore, from one MRI image to another, the muscle, for example, as soft tissue, is not

represented by the same gray level. Thus, fusion of an MRI image with a scanner image results in a final image whose scale is not absolute.

In other words, the fusion of an image possessing an absolute scale with another image not possessing an absolutely scale results in a final image not possessing any absolute scale.

Furthermore, an image not possessing any absolute scale cannot be used by any of the current scanner image processing software. In fact, all of that software uses a standard gray level format, which is the Hounsfield scale. Thus, a final image originating from the fusion of both scanner and MRI images is incompatible with any scanner image processing software. It is necessary to develop specific image processing software not calibrated on the Hounsfield scale, in order to be able to use said final image.

The invention is aimed at introducing a solution to that problem by a scaling of the gray levels of the MRI image, in order to render the final image compatible with all scanner image processing software. In other words, the final image will be calibrated on the Hounsfield scale.

One object of the invention is to reduce the cost of investment in the development of specific software, if it is desired to carry out digital processing on said final image.

Another object of the invention is to use a final image of fusion obtained according to the method of the invention as image source for the standard radiotherapy software, which is not the case with the fused images in the present state of the art.

The invention therefore proposes a method of fusion of a first digital radiographic image obtained as a result of scanning with a second digital radiographic image obtained by magnetic resonance imaging (MRI).

According to a general characteristic of the invention, a CT interval of gray levels is selected in the scanner image and each pixel of said scanner image

having a gray level lying within the CT interval is replaced by a pixel obtained by digital processing of the pixel of the same coordinates as the MRI image. The final image therefore corresponds to the scanner image in which the pixels of gray levels lying within the CT interval are thus modified.

Furthermore, with a view to effective digital processing, a two-dimensional recentering of both MRI and scanner images is carried out by means of at least one rotation and/or translation operation, so that a pixel of the scanner image of coordinates (x,y) and a pixel of the MRI image of the same coordinates (x,y) represent the same portion of the organ X-rayed.

In other words, the range of gray levels corresponding to the soft tissues is replaced by a new range of gray levels. The values of the gray levels of that new range are obtained from an algorithm introducing certain gray levels of the MRI image. For a given pixel of the CT interval in the scanner image, the algorithm calculates the gray level value of the new pixel from a pixel of the MRI image having the same coordinates as the pixel of the CT interval having to be replaced.

According to one method of use of the invention, the upper limit $B_{CT}$ of the CT interval is fixed at a gray level value on the Hounsfield scale, said gray level corresponding to the highest value of the gray levels representing the soft tissues visualized on the scanner image. The lower limit $A_{CT}$ of the CT interval is fixed at a gray level value on the Hounsfield scale, said gray level corresponding to the lowest value of the gray levels representing soft tissues visualized on the scanner image.

More precisely, two thresholds are fixed, defining the CT interval corresponding to the soft tissues in the scanner image.

In practice, $B_{CT}$ is fixed as the highest value of the soft tissues in the scanner image and $A_{CT}$ is fixed as the lowest value of the soft tissues in the scanner image.

The interval thus selected is an interval included in the Hounsfield scale, since the scanner image is calibrated on that scale.

In general, according to one method of use of the invention, one selects an MR interval of gray levels in the MRI image, whose upper limit $B_{MR}$ corresponds to a gray level above which the pixels are white, and whose lower limit $A_{MR}$ corresponds to a gray level below which the pixels are black.

In other words, that interval takes into account all of the variation of gray levels in the MRI image. This variation, this contrast, represents the useful information on the soft tissues.

There are then two intervals, a first CT interval in the scanner image included in the Hounsfield scale and a second MR interval in the MRI image not linked to the Hounsfield scale. These two intervals represent a framing of the soft tissues.

According to a method of use of the invention, the digital processing consists of a linear interpolation by means of an affine function integrating the value of the lower limit $A_{CT}$ and upper limit $B_{CT}$ of the CT interval in the scanner image and the value of the lower limit $A_{MR}$ and upper limit $B_{MR}$ of the MR interval in the MRI image.

Carrying out a linear interpolation makes it possible to respect the choice of contrast in the MRI image.

Preferably, for a scanner pixel having a gray level $V_{CT}$ lying within the CT interval, the gray level $V_{MR}$ of the pixel of the same coordinates in the MRI image is determined, and then a gray level in the CT interval is determined from said affine function and from said level $V_{MR}$. The gray level $V_{OUT}$ of each pixel of the final image can then be obtained by the following algorithm:

- if $V_{CT} < A_{CT}$, then

1) $V_{OUT} = V_{CT}$,

- if $V_{CT} > B_{CT}$, then

2) $V_{OUT} = V_{CT}$,

- if $A_{CT} < V_{CT} < B_{CT}$, then

3) $V_{OUT} = A_{CT} + (B_{CT} - A_{CT})(V_{MR} - A_{MR})/(B_{MR} - A_{MR})$.

In other words, while maintaining the resolution of the MRI image, the MRI image is scaled so that the black level $A_{MR}$ of the MRI image corresponds to the lowest value $A_{CT}$ of the soft tissues in the scanner image. Likewise, the white level $B_{MR}$ of the MRI image corresponds to the highest value $B_{MR}$ of the soft tissues in the scanner image.

In fact:

- for $V_{MR} = B_{MR}$, highest gray level in the MR interval of the MRI image,

one obtains by 3) $V_{OUT} = B_{CT}$, highest gray level in the CT interval of the scanner image,

- and for $V_{MR} = A_{MR}$, lowest gray level in the MR interval of the MRI image,

one obtains by 3) $V_{OUT} = A_{CT}$, lowest gray level in the CT interval of the scanner image.

Scaling causes the MR interval not calibrated on the Hounsfield scale of the MRI image to undergo a digital processing which makes it correspond to the CT interval lying within the Hounsfield interval.

Thus, all the gray level values $V_{OUT}$ of the final image will be contained in the Hounsfield scale, which is the standard scale of scanner image processing.

The invention also concerns a system of fusion of a first digital radiographic image obtained by scanning with a second digital radiographic

image obtained by MRI, comprising:

- a means of reading pixels of the scanner image, the gray levels of which lie within a predetermined CT interval,

- a means of reading pixels of the MRI image, the coordinates of which are identical to those of the pixels of the CT interval of the scanner image,

- a means of calculation of a third image composed of the scanner image in which the pixels whose gray levels lie within the CT interval are replaced by pixels obtained by digital processing of the pixels of the same coordinates as the MRI image in order to obtain an image making possible visualization of the soft tissues and bony tissues.

The final image obtained is of the scanner type. It can therefore be processed by standard software such as Advantage Sim or even Advantage Windows 3D Viewer, which is not the case with the fusion images of the prior art. The methods of the prior art require the use of specific software in order to be able to process their fusion images.

Other advantages and characteristics of the invention will appear on examination of the detailed specification of a nonlimitative embodiment and of the attached drawings, in which:

## BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 is a flow chart of an embodiment of the method according to the invention;

- Figure 2 schematically illustrates two images obtained by a tomography system.

## DETAILED DESCRIPTION OF THE INVENTION

Referring in particular to the three Figures 1, 3 and 4, first of all, the two digital images are acquired. Acquisition 1 makes it possible to obtain a scanner

image 11 illustrated in Figure 3. This image represents a view of a patient's head along a given plane. A part outside the head can be distinguished there, that is, the air 12 represented in black. The white zone 14 corresponds to the bony tissues and all the grayish zones 13 correspond to the soft tissues. The scanner image 11 is of particular interest because it favors visualization of the bony tissue. Its principal characteristic is therefore a perfect display of the bony tissues 14. On the other hand, the grayish zones 13 have a poor resolution, so that it is impossible to distinguish the contrasts in the soft tissues.

Acquisition 2 makes it possible to obtain an image 15 by magnetic resonance imaging. It represents a view of a patient's head along the same plane as the scanner image 11. A black part 16 can also be distinguished there, corresponding to the air all around the head. Inside the head, the black zones 17 correspond to the bony tissues and to any element other than the soft tissues, like air, for example. The grayish zones 18 represent the soft tissues. The principal characteristic of that image is the display of soft tissues. The resolution is sufficient to distinguish contrasts, elements of interest 19. On the other hand, it is difficult to delimit the bony parts 17, for they are merged with the air and every other element appearing in black on the image 15.

These two images 11 and 15 originating from two different methods of acquisition 1 and 2 represent a view of the head along a given cutting plane. Thus, a two-dimensional recentering 3 is made in order to render the two images 11 and 15 superposable. For this purpose, rotation and/or translation operations are possibly carried out. There are tools known to the expert that make it possible to control said recentering operation 3. One can mention, notably, the tool using a pointer, that is, a particular element is pointed to on the scanner image 11, for example, and a cursor appears on the same particular element on the MRI image 15. The same idea is exploited in the tool using a magnifier.

Once the two images 11 and 15 are recentered, one determines in stage 4 the lowest value $A_{CT}$ of the soft tissues in the scanner image, for example, -130,

which is a low value of soft tissues in the Hounsfield scale. One also determines the highest value $B_{CT}$ of soft tissues in the scanner image, for example, 80, which is a high value of soft tissues in the Hounsfield scale. These two values are both CT numbers. A CT number is defined from the attenuation coefficient of the tissue considered and from the attenuation coefficient of water:

$$CT\ Number = \frac{\mu_0 - \mu_w}{\mu_w} x1000$$

with $\mu_w$: attenuation coefficient of water

$\mu_0$: attenuation coefficient of the tissue considered.

The CT number is expressed in Hounsfield unit.

Table of CT numbers

| *ELEMENTS OF THE HUMAN BODY* | *CT NUMBER* |
|---|---|
| BONE (CORTEX) | > 250 |
| BONE (MARROW) | 130 ± 100 |
| COAGULATED BLOOD | 80 ± 10 |
| THYROID GLAND | 70 ± 10 |
| LIVER | 50 ± 10 |
| MUSCLE | 45 ± 5 |
| BLOOD | 40 ± 10 |
| BRAIN (WHITE MATTER) | 35 ± 5 |
| KIDNEY | 30 ± 10 |
| BRAIN (GRAY MATTER) | 25 ± 5 |
| FATTY TISSUE | -100 ± 10 |

Two values $A_{MR}$ and $B_{MR}$ on the MRI image are also determined in stage 5. $A_{MR}$ is a gray level such that the lower gray levels are considered black. $B_{MR}$ is a gray level such that the higher gray levels are considered white.

One then proceeds with an algorithm 6 making possible scaling of the MR interval. According to a preferred embodiment of the invention, algorithm 6 is applied in accordance with Figure 2. A target pixel of the scanner image of gray level equal to $V_{CT}$ is taken in the course of stage 6a. In the first place, it is going to be determined whether that value is included in the CT interval. For that purpose, both values of the lower limit $A_{CT}$ and upper limit $B_{CT}$ are introduced. First of all, said value $V_{CT}$ is compared to value $A_{CT}$ in the course of stage 6b. If the gray level of the target pixel $V_{CT}$ is less than $A_{CT}$, then the target pixel is outside the CT interval and it can then correspond to the bony tissue 14 or to the black background 12 of the scanner image. In that case, the target pixel maintains its value $V_{CT}$ on the final image 20.

Otherwise, if the gray level $V_{CT}$ is higher than $A_{CT}$, it is compared in the course of stage 6c to value $B_{CT}$. If the gray level $V_{CT}$ is higher than the upper limit $B_{CT}$ of the CT interval, then said target pixel maintains its value $V_{CT}$ on the final image 20 in the course of stage 6f, that is, $V_{OUT}$, the gray level of the target pixel on the final image 20, is equal to $V_{CT}$. Thus, for a value $V_{CT}$ lower than $A_{CT}$ or higher than $B_{CT}$, said level $V_{CT}$ is maintained as gray level $V_{OUT}$ of the final image 20.

On the other hand, if $V_{CT}$ is higher than $A_{CT}$ and lower than $B_{CT}$, the gray level $V_{MR}$ of a pixel of the MRI image of the same coordinates as said target pixel of the scanner image is then determined in the course of stage 6d. It is then made to undergo a linear inter-polation at that gray level $V_{MR}$ by introducing levels $A_{CT}$, $B_{CT}$, $A_{MR}$ and $B_{MR}$. A new value $V_{OUT}$ independent of $V_{CT}$ is then obtained in the course of stage 6e.

Algorithm 6 is presented in that case in the form:

- if $V_{CT} < -130$, then

1) $V_{OUT} = V_{CT}$,

- if $V_{CT} > 80$, then

2) $V_{OUT} = V_{CT}$,

- if $-130 < V_{CT} < 80$, then

3) $V_{OUT} = -130 + (80 + 130)(V_{MR} - A_{MR})/(B_{MR} - A_{MR})$.

Whatever the values $A_{MR}$ and $B_{MR}$, the final image 20 presents a range of gray levels according to the Hounsfield scale. Figure 5 shows said final image 20 in which the bony tissues 14 as well as the soft tissues 18 are distinguished. The background of the image 12 remains black, as on the scanner image 11.

However, for a scanner image obtained according to a view of the lungs, a pixel of gray level $V_{CT}$ representing said lungs in the scanner image will have value $V_{OUT}$ equal to $V_{CT}$ in the final image, whatever the gray level $V_{CT}$ included or not in the CT interval. In other words, if the gray levels of the lungs in the final image are the gray levels of the lungs in the scanner image, the linear interpolation is not applied on the gray levels of the lungs. This is due to the fact that the gray levels representing the lungs possess such dynamics that the scanner image has a better resolution than the MRI image.

The final image 20, whose gray levels are contained in the Hounsfield scale, was thus determined. This final image is then safeguarded in stage 7 in the form of a scanner image. It can be printed in stage 10 or even displayed in stage 8 on a screen for possible study. But the main advantage of that methods resides in the fact that this image can be delivered on entry of a standard radiotherapy treatment system in stage 9.

The final image originating from fusion of a scanner image with an MRI image reveals soft tissues as well as bony tissues and can be used a source for all standard scanner image processing software, such as Advantage Sim, Isis or even Advantage Windows Viewer.

Various modifications in structure and/or steps and/or function may be made by one skilled in the art without departing from the scope of the invention.

WHAT IS CLAIMED IS:

1. Method of fusion of a first digital radiographic image obtained as a result of scanning with a second digital radiographic image obtained by magnetic resonance imaging (MRI), in which a CT interval of gray levels is selected in the scanner image and each pixel of said scanner image having a gray level lying within the CT interval is replaced by a pixel obtained by digital processing of the pixel of the same coordinates as the MRI image, the final image corresponding to the scanner image in which the pixels of gray levels lying within the CT interval are thus modified.

2. Method according to Claim 1, characterized in that a two-dimensional recentering of both MRI and scanner images is carried out by means of at least one rotation and/or translation operation, so that a pixel of said scanner image of coordinates (x,y) and a pixel of the MRI image of the same coordinates (x,y) represent the same portion of the organ X-rayed.

3. Method according to one of the foregoing claims, characterized in that the upper limit $B_{CT}$ of the CT interval is fixed at a gray level value on the Hounsfield scale, said gray level corresponding to the highest value of the gray levels representing the soft tissues visualized on the scanner image.

4. Method according to one of the foregoing claims, characterized in that the lower limit $A_{CT}$ of the CT interval is fixed at a gray level value on the Hounsfield scale, said gray level corresponding to the lowest value of the gray levels representing soft tissues visualized on the scanner image.

5. Method according to one of the foregoing claims, characterized in that one selects another MR interval of gray levels in the MRI image, whose upper limit $B_{MR}$ corresponds to a gray level above which the pixels are white.

6. Method according to Claim 5, characterized in that the lower limit $A_{MR}$ of the MR interval corresponds to a gray level below which the pixels are black.

7. Method according to one of the foregoing claims, characterized in that the digital processing consists of a linear interpolation.

8. Method according to Claim 7, characterized in that the linear interpolation introduces an affine function integrating the value of the lower limit $A_{CT}$ and upper limit $B_{CT}$ of the CT interval in the scanner image and the value of the lower limit $A_{MR}$ and upper limit $B_{MR}$ of the MR interval in the MRI image.

9. Method according to Claim 8, characterized in that for a scanner pixel having a gray level $V_{CT}$ lying within the CT interval, the gray level $V_{MR}$ of the corresponding pixel in the MRI image is determined, and then a gray level in the CT interval is determined from said affine function and from said level $V_{MR}$; the gray level $V_{OUT}$ of each pixel of the final image is then obtained by the following algorithm:

- if $V_{CT} < A_{CT}$, then

1) $V_{OUT} = V_{CT}$,

- if $V_{CT} > B_{CT}$, then

2) $V_{OUT} = V_{CT}$,

- if $A_{CT} < V_{CT} < B_{CT}$, then

3) $V_{OUT} = A_{CT} + (B_{CT} - A_{CT})(V_{MR} - A_{MR})/(B_{MR} - A_{MR})$.

10. System of fusion of a first digital radiographic image obtained by scanning with a second digital radiographic image obtained by MRI, characterized in that it comprises:

- a means of reading pixels of the scanner image, the gray levels of which lie within a predetermined CT interval,

- a means of reading pixels of the MRI image, the coordinates of which are identical to those of the pixels of the CT interval of the scanner image,

- a means of calculation of a third image composed of the scanner image in which the pixels whose gray levels lie within the CT interval are replaced by pixels obtained by digital processing of the pixels of the same coordinates as the MRI image in order to obtain an image making possible visualization of the soft tissues and bony tissues.

FIG.1

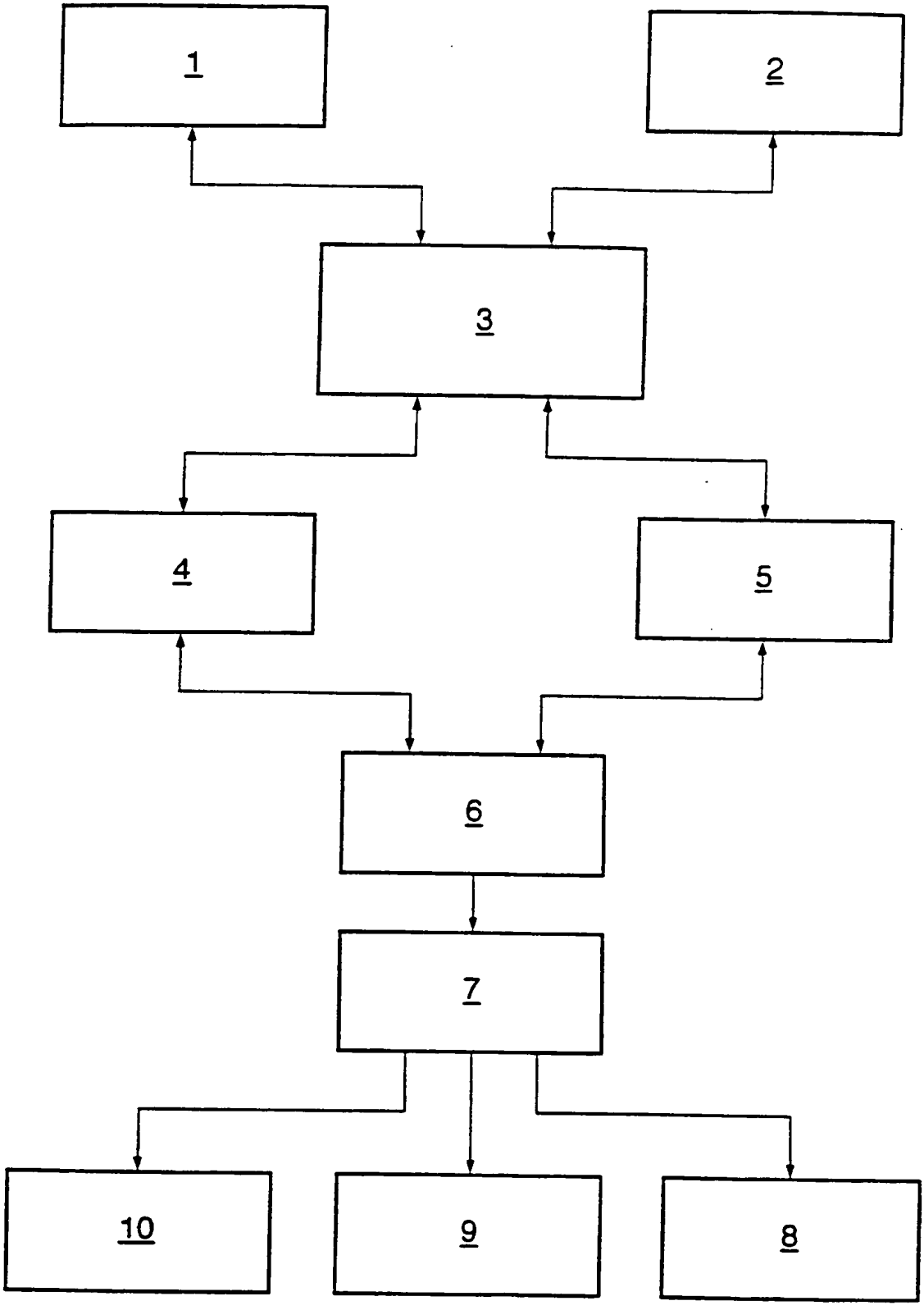


FIG.2

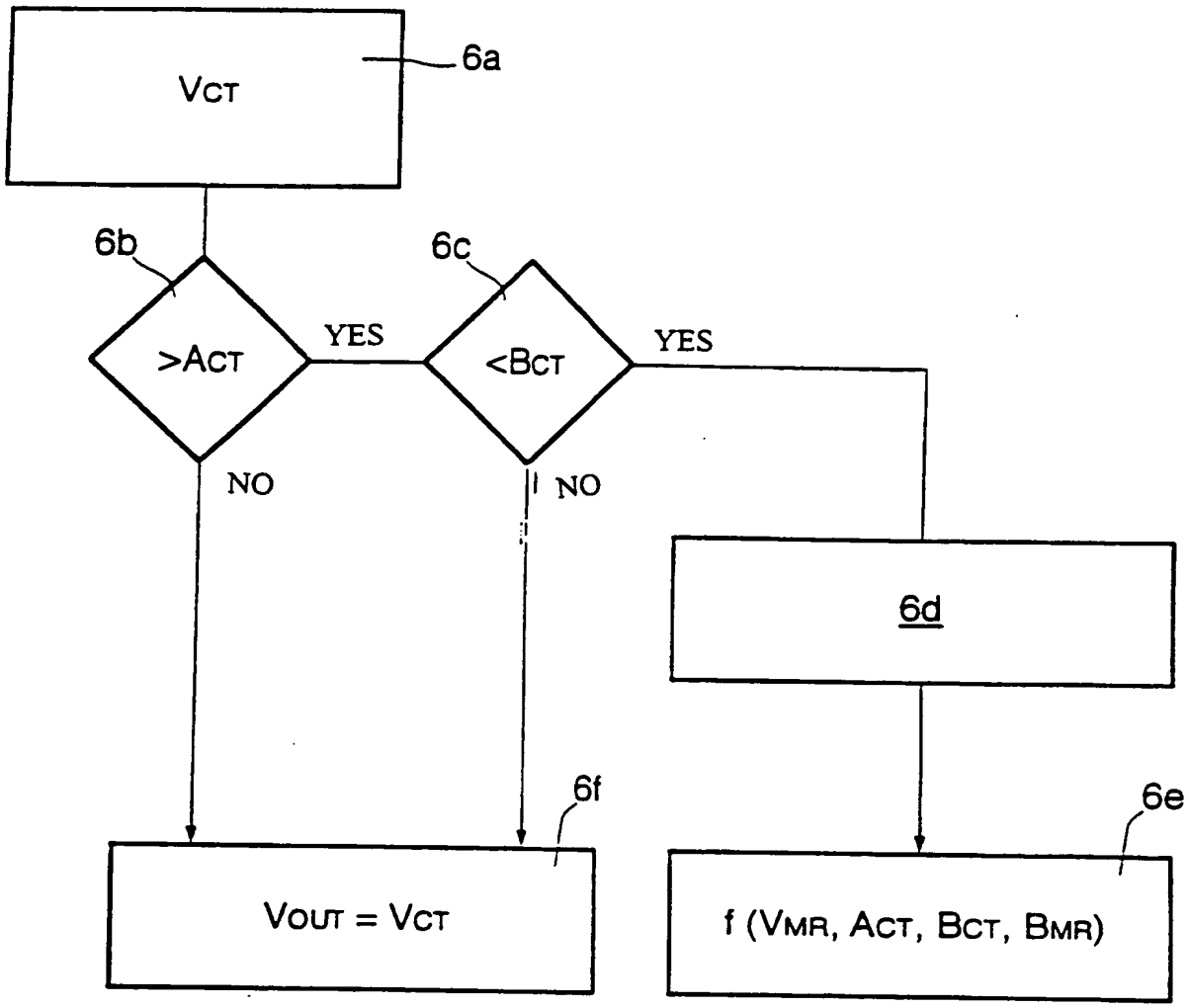

VCT
6a
6b
6c
>ACT
YES
<BCT
YES
NO
NO
6d
6f
6e
VOUT = VCT
f (VMR, ACT, BCT, BMR)

FIG.5

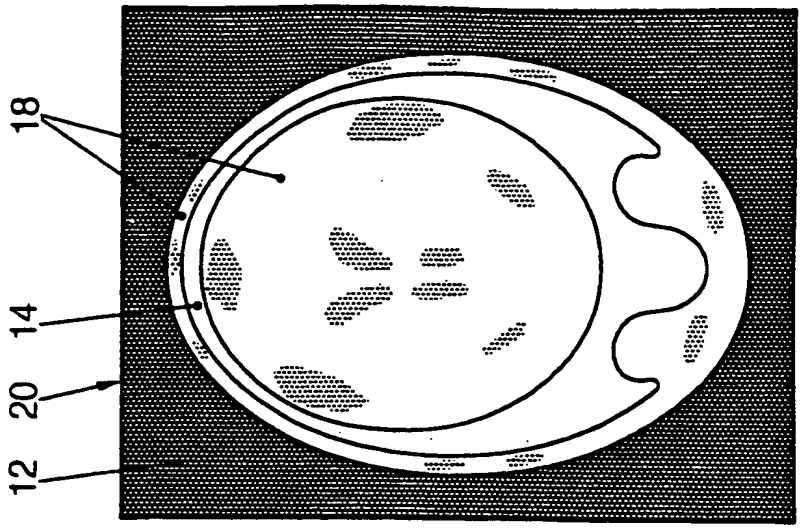



FIG.4

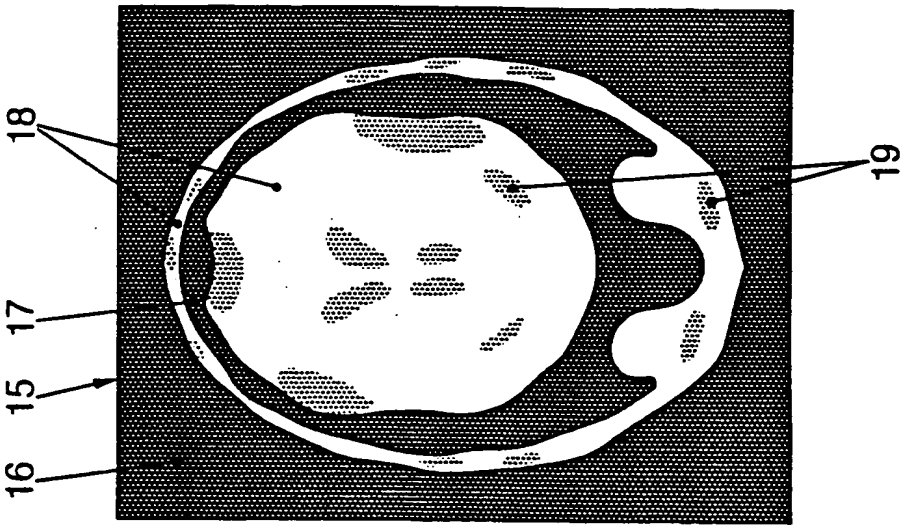
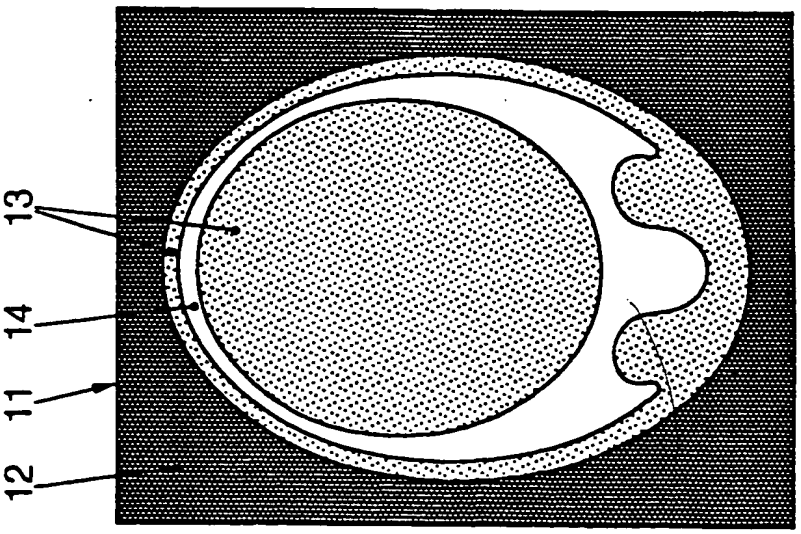



FIG.3



# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

# PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

To:
GENERAL ELECTRIC COMPANY
Attn. CHASKIN, J.
3135 Easton Turnpike W3C
Fairfield, CT 06431
UNITED STATES OF AMERICA

RECEIVED
OCT -9 2000
IPO
GENERAL ELECTRIC CO.

| | |
|---|---|
| | Date of mailing *(day/month/year)* 05/10/2000 |
| Applicant's or agent's file reference 14XZ00074 | **FOR FURTHER ACTION** See paragraphs 1 and 4 below |
| International application No. PCT/IB 00/ 00606 | International filing date *(day/month/year)* 28/04/2000 |
| Applicant GE MEDICAL SYSTEM SA | |

1. [X] The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**
The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

**For more detailed instructions,** see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

| | |
|---|---|
| Name and mailing address of the International Searching Authority<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br>Marja Brouwers |

Form PCT/ISA/220 (July 1998)

## NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

## INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

**What parts of the international application may be amended?**

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

**When?** Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

**Where not to file the amendments?**

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

**How?** Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

**The amendments must be made in the language in which the international application is to be published.**

**What documents must/may accompany the amendments?**

**Letter (Section 205(b)):**

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

**The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.**

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

**The following examples illustrate the manner in which amendments must be explained in the accompanying letter:**

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

**"Statement under article 19(1)" (Rule 46.4)**

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

**It must be in the language in which the international appplication is to be published.**

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

**Consequence if a demand for international preliminary examination has already been filed**

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

**Consequence with regard to translation of the international application for entry into the national phase**

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

| Applicant's or agent's file reference | FOR FURTHER ACTION | see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below. |
|---|---|---|
| 14XZ00074 | | |
| International application No. | International filing date *(day/month/year)* | (Earliest) Priority Date *(day/month/year)* |
| PCT/IB 00/ 00606 | 28/04/2000 | 29/04/1999 |
| Applicant | | |
| GE MEDICAL SYSTEM SA | | |

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 00/00606

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T5/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
INSPEC, WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 5 672 877 A (LIEBIG JOHN R ET AL)<br>30 September 1997 (1997-09-30) | 1-9 |
| X | abstract<br>column 2, line 40 - line 59<br>column 11, line 1 - line 52<br>--- | 10 |
| Y | SHARMA R K ET AL: "39.2: MULTISENSOR IMAGE REGISTRATION"<br>SID INTERNATIONAL SYMPOSIUM DIGEST OF TECHNICAL PAPERS,US,SANTA ANA, SID,<br>vol. 28, page 951-954 XP000722843<br>ISSN: 0097-966X<br>abstract<br>paragraph '0002! - paragraph '0003!<br>---<br>-/-- | 1-9 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 27 September 2000 | 05/10/2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.<br>Fax: (+31-70) 340-3016 | Gonzalez Ordonez, O |

Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

In ational Application No
PCT/IB 00/00606

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | MITICHE A ET AL: "MULTIPLE SENSOR INTEGRATION/FUSION THROUGH IMAGE PROCESSING: A REVIEW" OPTICAL ENGINEERING,US,SOC. OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS. BELLINGHAM, vol. 25, no. 3, page 380-386 XP000718279 ISSN: 0091-3286 page 382, paragraph INTEGRATION.OF.INFORMATION page 382, paragraph IMAGE.REGISTRATION | 1,2 |

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Ir .ational Application No
PCT/IB 00/00606

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5672877 A | 30-09-1997 | AU 1954197 A | 17-10-1997 |
| | | CN 1220009 A | 16-06-1999 |
| | | DE 19781676 T | 15-04-1999 |
| | | WO 9736190 A | 02-10-1997 |

REPUBLIQUE FRANÇAISE

INSTITUT NATIONAL
de la
PROPRIETE INDUSTRIELLE

# RAPPORT DE RECHERCHE PRELIMINAIRE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

N° d'enregistrement national
FA 571346
FR 9905438

## DOCUMENTS CONSIDERES COMME PERTINENTS

| Catégorie | Citation du document avec indication, en cas de besoin, des parties pertinentes | Revendications concernées de la demande examinée |
|---|---|---|
| Y | US 5 672 877 A (LIEBIG JOHN R ET AL) 30 septembre 1997 (1997-09-30) | 1-9 |
| X | * abrégé * * colonne 2, ligne 40 - ligne 59 * * colonne 11, ligne 1 - ligne 52 * | 10 |
| Y | SHARMA R K ET AL: "39.2: MULTISENSOR IMAGE REGISTRATION" SID INTERNATIONAL SYMPOSIUM DIGEST OF TECHNICAL PAPERS,US,SANTA ANA, SID, vol. 28, page 951-954 XP000722843 ISSN: 0097-966X * abrégé * * alinéa '0002! - alinéa '0003! * | 1-9 |
| A | MITICHE A ET AL: "MULTIPLE SENSOR INTEGRATION/FUSION THROUGH IMAGE PROCESSING: A REVIEW" OPTICAL ENGINEERING,US,SOC. OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS. BELLINGHAM, vol. 25, no. 3, page 380-386 XP000718279 ISSN: 0091-3286 * page 382, alinéa INTEGRATION.OF.INFORMATION * * page 382, alinéa IMAGE.REGISTRATION * | 1,2 |

DOMAINES TECHNIQUES RECHERCHES (Int.CL.6)

G06T

Date d'achèvement de la recherche
21 décembre 1999

Examinateur
Gonzalez Ordonez, O

CATEGORIE DES DOCUMENTS CITES

X : particulièrement pertinent à lui seul
Y : particulièrement pertinent en combinaison avec un autre document de la même catégorie
A : pertinent à l'encontre d'au moins une revendication ou arrière-plan technologique général
O : divulgation non-écrite
P : document intercalaire

T : théorie ou principe à la base de l'invention
E : document de brevet bénéficiant d'une date antérieure à la date de dépôt et qui n'a été publié qu'à cette date de dépôt ou qu'à une date postérieure.
D : cité dans la demande
L : cité pour d'autres raisons

& : membre de la même famille, document correspondant



EPO FORM 1503 03.82 (P04C13)

## ANNEXE AU RAPPORT DE RECHERCHE PRELIMINAIRE RELATIF A LA DEMANDE DE BREVET FRANÇAIS NO.

FA 571346
FR 9905438

La présente annexe indique les membres de la famille de brevets relatifs aux documents brevets cités dans le rapport de recherche préliminaire visé ci-dessus.
Lesdits membres sont contenus au fichier informatique de l'Office européen des brevets à la date du
Les renseignements fournis sont donnés à titre indicatif et n'engagent pas la responsabilité de l'Office européen des brevets, ni de l'Administration française

21-12-1999

| Document brevet cité au rapport de recherche | Date de publication | Membre(s) de la famille de brevet(s) | Date de publication |
|---|---|---|---|
| US 5672877 A | 30-09-1997 | AU 1954197 A | 17-10-1997 |
| | | CN 1220009 A | 16-06-1999 |
| | | DE 19781676 T | 15-04-1999 |
| | | WO 9736190 A | 02-10-1997 |

EPO FORM P0465

Pour tout renseignement concernant cette annexe : voir Journal Officiel de l'Office européen des brevets, No.12/82